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Rapid review

The effectiveness and cost-effectiveness of prophylactic removal of wisdom teeth

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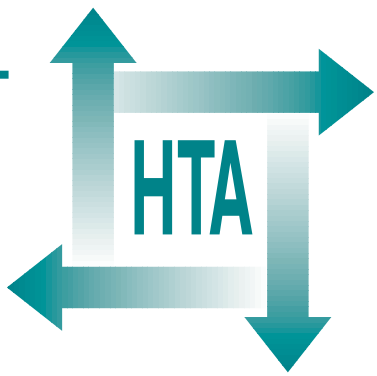
Health Technology Assessment
NHS R&D HTA Programme



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The effectiveness and cost-effectiveness of prophylactic removal of wisdom teeth

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List of abbreviations

3M(s)	third molar(s)*
AL	arch length*
CCTR	Cochrane Controlled Trials Register
CI	confidence interval*
DSD	days of standard discomfort
ICW	intercanine width*
LII	Little's Irregularity Index*
NICE	National Institute for Clinical Excellence
RCT	randomised controlled trial
SCI	Science Citation Index
SD	standard deviation*
SIGN	Scottish Intercollegiate Guidelines Network

* Used only in tables

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Executive summary

Background

Removal of wisdom teeth is one of the most common surgical procedures performed in the UK. Little controversy surrounds the removal of impacted third molars when they are associated with pathological changes such as infection, non-restorable carious lesions, cysts, tumours, and destruction of adjacent teeth and bone. However, the justification for prophylactic removal of impacted third molars is less certain and has been debated for many years.

Objectives

- To provide a summary of existing evidence on prophylactic removal of impacted wisdom teeth, in terms of the incidence of surgical complications associated with prophylactic removal, and the morbidity associated with retention.

Methods

A systematic review of the research literature was undertaken.

Data sources

An existing review formed the basis of this report, and additional literature searches were undertaken, including searches of electronic databases (MEDLINE, 1984–99; EMBASE, 1984–99; Science Citation Index, Cochrane Controlled Trials Register, National Research Register; Database of Abstracts of Reviews of Effectiveness), paper sources (including *Clinical Evidence*), and web-based resources. Relevant organisations and professional bodies were contacted for further information.

Study selection

Studies were selected for inclusion if they met the following criteria:

- design – randomised controlled trials (RCTs), literature reviews, or decision analyses
- participants – people with unerupted or impacted third molars, or those undergoing surgical removal of third molars either as prophylaxis or due to associated pathological changes
- reported outcomes – either the pathological changes associated with retention of third molars, or post-operative complications following extraction.

There were no language restrictions on study selection.

Data extraction and synthesis

Data from included studies were extracted into structured tables and individual study validity was assessed against methodological checklists. Data were summarised descriptively. Decisions relating to study selection, data extraction and validity assessment were made by two independent reviewers, and disagreements were resolved by discussion. For non-English papers, translators were recruited to assist with study selection and data extraction.

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Results

Forty studies were included in the review: two RCTs, 34 literature reviews, and four decision analysis studies.

One RCT in the UK focused on the effects of retained third molars on incisor crowding (predominantly a cosmetic problem) in patients who had previously undergone orthodontic treatment. The results of this trial suggested that the removal of third molars to prevent late incisor crowding cannot be justified. Another on-going RCT in Denmark compares the effects and costs of prophylactic removal of third molars with removal according to morbidity. So far, this trial has recruited 200 participants, and preliminary results indicate that watchful waiting may be a promising strategy. However, more data and longer follow-up of patients are needed to conclude which treatment strategy is the most cost-effective. It is also known that a trial is on-going in the USA but no results are available so far.

The methodological quality of the literature reviews was generally poor, and none of the reviews

was systematic. Conclusions from nine reviews on anterior crowding suggested that there was only a weak association between retention of third molars and crowding. Six out of 21 reviews with a more general scope also concluded that the prophylactic removal of third molars was unjustified. Twelve general reviews did not conclude with a clear message about the management of third molars. Three reviews suggested that prophylactic removal of third molars is appropriate, but these reviews were of poorer methodological quality than the majority of other reviews. Three out of four papers focusing on surgical management expressed uncertain conclusions relating to the prophylactic extraction of third molars.

It is difficult to compare prophylactic removal of impacted third molars with retention in the absence of disease, partly because these two strategies are related to different types of outcomes. By using utility methods, four decision analyses made it possible to compare different outcomes directly in the coherent models. Although there were important differences in the structure and methods for estimating input values, the findings of the decision analyses (by two groups of researchers) consistently suggested that retention of third molars was cost-saving and more cost-effective compared with prophylactic removal of impacted third molars.

Conclusions

There is no reliable research evidence to support the prophylactic removal of disease-free impacted third molars. Available evidence suggests that retention may be more effective and cost-effective than prophylactic removal, at least in the short to medium term.

Recommendations for research

1. Although data from observational studies may be useful, there is a need for well-designed RCTs to compare prophylactic removal with management by deliberate retention, using long-term follow-up.
2. There is also a need for decision analysis models that could be used to compare long-term outcomes of prophylactic removal with retention of impacted third molars.

Chapter 1
Background

Introduction

Removal of third molars (wisdom teeth) is one of the most common surgical procedures performed in the UK. In 1994–95 there were over 36,000 in-patient and 60,000 day-case admissions in England for 'surgical removal of tooth'.[1] Third molar surgery has been estimated to cost the NHS in England up to £30 million per year,[2] and approximately £20 million is spent annually in the private sector.[3] Around 90% of patients on waiting lists for oral and maxillofacial surgery are scheduled for third molar removal.[3]

There are wide variations in rates of third molar surgery across the UK.[2,4] There is some evidence that deprived populations with poor dental health are less likely to have third molars removed compared with more affluent populations with good dental health.[2,5] However, the reasons for this are complex.

The proportion of third molar surgery which is carried out prophylactically is difficult to estimate precisely and depends on the definitions used. Some estimates of prophylactic removal suggest rates of between 20% and 40%,[6–8] but rates as low as 4% have been reported.[9] A UK survey of 181 consultants found that of 19,971 third molars referred to hospital for assessment, and subsequently removed, 43.9% were disease-free.[10] This survey also revealed that relatively more maxillary third molars than mandibular third molars were removed prophylactically. The rate of disease-free extracted teeth was 79.0% in 7735 maxillary third molars and 21.8% in 12,236 mandibular third molars.[10]

Little controversy surrounds the removal of impacted third molars when they are associated with pathological changes such as infection, non-restorable carious lesions, cysts, tumours, and destruction of adjacent teeth and bone.[11,12] However, the justification for prophylactic removal of impacted third molars is less certain and has been debated for many years.

Several reasons are given for the early removal of disease-free impacted third molars: they have no useful role in the mouth; they may increase the risk of pathological changes and symptoms; if they are removed only when pathological changes occur, patients may be older and the risk of serious post-operative complications may be greater.

On the other hand, the probability of impacted third molars causing pathological changes in the future may be exaggerated.[3,13] Many impacted or unerupted third molars may eventually erupt normally and many impacted third molars never cause clinically important problems.[14] In addition, third molar surgery is not risk-free. The complications and suffering following third molar surgery may be considerable.[15]

Therefore, the decision to remove third molars prophylactically should be based on an estimate of the balance between the likelihood of retained third molars causing problems in the future and the risks or advantages of surgery carried out earlier compared with later. However, it is not possible to predict reliably whether impacted third molars will develop pathological changes if they are not removed. Wide variation has been observed among practitioners in their perceived risk of future associated pathological changes and in treatment decisions in the management of impacted third molars.[16–18]

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Impacted third molars

Impaction occurs where there is prevention of complete eruption into a normal functional position of one tooth by another, due to lack of space (in the dental arch), obstruction by another tooth, or development in an abnormal position. According to the definitions given by the Faculty of Dental Surgery of the Royal College of Surgeons of England,[12] a tooth that is completely impacted is entirely covered by soft tissue and partially or completely covered by bone within the mandible (lower jaw) or maxilla (upper jaw); partial eruption occurs when the tooth is visible in the mouth but has failed to erupt into a normal functional position.

It should be noted that any normally erupted teeth used to be unerupted and partially erupted at certain stages of eruption process. Therefore,

unerupted or partially erupted teeth may not be impacted.[12]

Pathological changes associated with impacted third molars

Impacted third molars may be associated with certain pathological changes such as infections, dental caries, destruction of adjacent teeth, cysts and tumours. Although impacted third molars do not necessarily cause some of these pathological changes (such as dental caries), the impaction may increase the risk of disease, particularly when oral hygiene is poor.

Pericoronitis (inflammation of the gingiva surrounding the crown of a tooth) is the most common indication for third molar surgery,[10] and mainly occurs in adolescents and young adults, and less commonly in older people.[19] One study reported that during 4 years of follow-up, 10% of lower third molars developed pericoronitis.[20]

Very few impacted third molars cause dental caries (decay) of second molars,[19] though estimates of the rate vary (1% to 4.5%).[15]

There is a low incidence (less than 1%) of root resorption of second molars with impacted third molars.[20,21] One review concluded that the risk of second molar root resorption by impacted third molars is low, and is likely to occur in younger patients for whom surgery is claimed to be associated with lower morbidity.[19]

The association between anterior (front) incisor crowding (predominantly a cosmetic problem) and impacted third molars is not significant and is not considered to warrant the removal of third molars.[22–24]

Cyst development is very rare and is not considered to be an indication for prophylactic removal.[19] The risk of malignant neoplasms arising in a dental follicle is negligible and is not considered to be an indication for prophylactic removal.[19]

Complications and risks following surgery

The potential benefit of avoiding the relatively uncommon risks of pathological changes associated with leaving impacted third molars in place needs to be considered alongside the risks associated with their removal.

Common complications following third molar surgery include temporary or permanent sensory nerve damage (including anaesthesia and paraesthesia), dry socket (alveolar osteitis, or dry appearance of the exposed bone in the socket), infection, haemorrhage and pain. Other possible complications include severe trismus (lockjaw), oro-antral fistula, buccal fat herniations, iatrogenic damage to the adjacent second molar, and iatrogenic mandibular fracture.

The rate of sensory nerve damage after third molar surgery has been shown to range from 0.5% to 20%.[15,19,25,26] The reported overall rate of dry socket varies from 0% to 35%.[15,27] The risk of dry socket increases with lack of surgical experience and tobacco use.[28]

Chapter 2

Aims and methods

Aims

This review aims to provide a summary of existing evidence on prophylactic removal of impacted wisdom teeth, in terms of the incidence of surgical complications associated with prophylactic removal and the morbidity associated with retention.

Methods

Selection criteria for studies

Studies were selected for inclusion if they met the following criteria.

Study design

Evaluations in the form of any relevant literature reviews (published as a full paper) or randomised controlled trials (RCTs) (published as a full paper, abstract, editorial, or letter) were considered for inclusion. Literature reviews could include both RCTs or other studies designed to address long-term outcomes. Papers in all languages were considered.

Participants

Studies recruiting people with unerupted or impacted third molars, and those undergoing surgical removal of unerupted or impacted third molars, either as prophylaxis or because of pathological changes, were eligible for inclusion.

Outcomes

Reported outcomes had to include either the pathological changes and/or symptoms associated with unerupted or impacted third molars, or outcomes following surgical removal of third molars.

Search strategy

An existing review formed the basis of this report.[23] Some additional searches of the following databases were carried out, with no language restrictions:

- MEDLINE (1984–99)
- EMBASE (1984–99)
- Science Citation Index (SCI) (via the BIDS service)
- Cochrane Controlled Trials Register (CCTR)
- National Research Register (NRR)
- Database of Abstracts of Reviews of Effectiveness (DARE)
- NHS Economic Evaluation Database (NHSEED).

Paper sources searched included *Clinical Evidence* (BMJ Publishing Group). A search on the following web-based resources was also carried out:

- Scottish Health Purchasing Information Centre (SHPIC) reports
- Scottish Intercollegiate Guidelines Network (SIGN) guidelines
- Agency for Health Care Policy and Research (AHCPR) clinical practice guidelines
- Guide to Clinical Preventive Guidelines, Development and Evaluation Committee (DEC) reports
- International Network of Agencies for Health Technology Assessment (INAHTA) published reports and ongoing reviews
- National Coordinating Centre for Health Technology Assessment (NCCHTA) reports
- Turning Research Into Practice (TRIP)
- resources produced by the University of Sheffield School of Health and Related Research (ScHARR), including 'Netting the Evidence' and the Internet Database of Evidence-Based Abstracts and Articles (IDEA) Topic List.

Other sources of information included The Faculty of Dental Surgery of the Royal College of Surgeons of England and The British Dental Association, who provided additional information as submission of evidence to the National Institute for Clinical Evidence (NICE). In addition, SIGN supplied the NHS Centre for Reviews and Dissemination with a draft copy of their forthcoming guidelines on the management of third molars. The reference lists of included articles were also checked to identify relevant studies.

The strategies used for searching MEDLINE, EMBASE, SCI, and CCTR are presented in appendix 1.

Decisions on the inclusion of studies

Titles and abstracts of studies identified by the

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searches were assessed for relevance by two independent reviewers. Any disagreements were resolved by discussion, and failing this, by recourse to a third reviewer. Full papers were retrieved if they appeared to meet the inclusion criteria, or if there was doubt as to whether they were eligible. Screening of full papers was checked independently by two reviewers, and disagreements were resolved as above.

Data extraction

Data were extracted into a structured table, and accuracy was checked by a second, independent, reviewer. Discrepancies were resolved through discussion. Different structured tables were used for reviews and RCTs. The data extracted from RCTs included study aims, method of randomisation, use of *a priori* power calculation, selection criteria for participants, baseline characteristics of groups, intervention details, numbers allocated to each group, setting of treatment, outcome measurements, statistical methods, results per group for each outcome, follow-up, withdrawals, and author's main conclusions. The data extracted from literature reviews included review aims, total number of references, and author's main conclusions.

For non-English papers, translators were recruited to assist with study selection and data extraction. The data extraction summary tables are shown in appendix 2 (*Tables 1 and 2*) for RCTs, in appendix 3 (*Table 3*) for literature reviews, and in appendix 4 (*Table 4*) for decision analysis studies.

Quality assessment

Selected articles were assessed by two reviewers independently, with discrepancies resolved though discussion. For RCTs the following aspects were assessed: participant selection criteria, sample size, reported use of *a priori* power calculation, method of randomisation, baseline comparability of treatment groups, use of blinded outcome assessment, appropriate use of statistical methods for data analysis, reporting of withdrawals, and use of the intention-to-treat analysis. For literature reviews the following were evaluated: clarity of review aims, literature search, selection criteria, validity assessment, presentation of details of primary studies, and methods of summarising data. The summary of validity assessment is shown in the data extraction tables (*Table 2,* appendix 2 and *Table 3,* appendix 3).

Data pooling

Data from literature reviews were summarised descriptively. Two RCTs were identified and these were not similar enough to allow for statistical pooling (meta-analysis) of results. Therefore, these data were also combined descriptively. Some cost-effectiveness data were identified in terms of the potential cost savings associated with reduced rates of prophylactic removal, which have been summarised as part of this report.

Chapter 3
Results

Included studies

The search strategy detailed in chapter 2 generated 4682 references of possible relevance to this review. Once titles (and, when available, abstracts) had been assessed, hard copies of 290 papers were examined. Of these, 40 studies were included in this review: two RCTs,[24,29] 34 literature reviews,[4,13,15,19,22,30–59] and four decision analysis studies.[26,60–62] One of the literature reviews was published as two separate papers.[51,52] Two papers published in French[63,64] duplicated an English language article, already included in this review.[15] One paper published in Danish could not be retrieved.[65]

One RCT is a UK study,[24] and the other, ongoing, trial is based in Denmark[29] (appendix 2). Twelve literature reviews were conducted in the USA, four in Canada, four in the UK, four in Italy, three in France, two in Belgium, and one each in Hungary, Switzerland, Finland, Sweden, and South Africa (appendix 3). Two of the decision analysis studies were conducted in the USA and two were conducted in the UK (appendix 4).

Excluded studies

A further 29 studies were closely considered for inclusion but were eventually excluded from the review.[66–94] Common reasons for exclusion included study design, discussion of impacted teeth other than third molars, or description of different surgical techniques or methods of treating post-operative complications. Details of excluded studies are shown in appendix 5 (*Table 5*).

Results from RCTs

Harradine and colleagues (1998)[24]

This UK-based trial focused on the effects of retained third molars on incisor crowding. A random number list was used to allocate participants to either extraction or retention of third molars. All patients had previously undergone orthodontic treatment. The mean age of entry to the trial was 14 years 10 months, and 55% of the sample were female. In total, 164 patients entered the trial, but only 77 (47%) were available for data collection at the 5-year follow-up.

There were no statistically significant changes over time between the two groups in terms of irregularity of dentition or intercanine width. There was, however, a small but statistically significant difference in decrease in arch length, with a slightly smaller decrease in the group that underwent surgery. A similar pattern of results was seen when some cases identified as having residual spacing from prior premolar extractions were excluded from the analysis. Generalised linear modelling showed that there were no statistically significant differences between those completing the study and those who were lost to follow-up.

Overall the trial was well conducted. However, there was no reported power calculation for sample size, and so the power of the study to detect true treatment effects is uncertain. In addition, there are few data relating to baseline characteristics of participants according to treatment arm.

Vondeling and colleagues (1999)[29]

This trial in Denmark is ongoing, and aims to assess the cost-effectiveness and clinical effectiveness of the prophylactic removal of third molars compared with extraction carried out according to associated morbidity. The method of randomisation was not described, but participants were allocated according to a blocked and stratified scheme. Only brief selection criteria were given, namely that participants had to be healthy, aged between 18 and 30 years, and to have at least one mandibular third molar remaining. No information was given about baseline characteristics of study groups. So far, 200 participants have been recruited, but this figure was not broken down by group. It is anticipated that by the end of the trial 500 participants will be recruited, 100 of whom will undergo prophylactic extraction. Only descriptive results were provided, and these suggested that prophylactic removal of third molars may be associated with decreased functional health status, increased healthcare costs and production losses, and that few patients in the watchful waiting group have developed pathological changes that would warrant removal of third molars. The authors

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cautiously suggest that watchful waiting may be the more favourable strategy, but further results are awaited with interest.

Results from literature reviews

Thirty-four published literature reviews were identified which fulfilled inclusion criteria for the review reported here. Data extraction summary tables are presented in appendix 3 (*Table 3*). Twenty-one of the assessed reviews covered general issues about the appropriateness of prophylactic removal of impacted third molars.[4,13,15,19,30,31,35,39–41,44,46,48,50–52,54–59] Nine reviews focused on the association of crowding with third molars,[22,32–34,38,42,43,49,53] and four reviews were concerned with complications following third molar surgery, namely, periodontal defect,[45] and sensory nerve damage.[36,37,47]

Methodological quality of the reviews

The methodological quality of the literature reviews was generally poor, and none could be described as systematic. Details of study quality assessment are shown with data extraction in appendix 3 (*Table 3*). With one exception,[4] none of the reviews gave details of using a structured search strategy to identify primary material or selection criteria for studies. The details of individual studies quoted in these literature reviews were usually insufficient for readers to judge the reliability of the evidence provided. Several reviews included very brief comments on the methodological quality of primary studies,[4,13,15,22,39,40,51,52] but none described a systematic assessment of validity. The literature included in these reviews included reviews and case reports as well as reports of studies that used a range of methodologies, including retrospective or prospective, cross-sectional or longitudinal observational studies. No RCTs comparing the long-term outcome of early removal with that of deliberate retention of disease-free third molars were identified. These literature reviews seldom quantitatively summarised the risk of removal or retention of impacted third molars.

Conclusions from reviews

Eight out of nine reviews on anterior crowding concluded that prophylactic removal of third molars for the prevention of crowding of lower anteriors was not justified.[22,32–34,42,43,49,53] The other review[38] recommended prophylactic removal of third molars, but review methods were very poor, and only nine references were cited overall. The conclusions from 12 of the 21 general reviews were uncertain and no clear answer was given about the appropriateness of prophylactic removal of impacted third molars.[15,30,31,35,39,40,48,50,55,57–59] Six of the general reviews concluded that prophylactic removal of impacted third molars was unjustified.[4,13,19,41,51,52,56] Three reviews[44,46,54] recommended the prophylactic removal of third molars but the methods used in each of these reviews were poorer than for many other reviews with different conclusions (appendix 3). Out of four papers focusing on surgical complications, three expressed uncertain conclusions,[37,45,47] and one was in favour of prophylactic removal.[36]

Decision analyses for third molar surgery

The appropriateness of prophylactic removal of impacted third molars should be evaluated by comparing the outcomes of prophylactic removal with the outcomes of retaining teeth. One difficulty in the comparison of the two strategies is in valuing and comparing the various outcomes. The outcome of surgical removal of impacted third molars is measured by the rate of various complications. On the other hand, the consequences of deliberate retention of impacted third molars in the absence of associated morbidity will include the incidence of different pathological changes and the rate of complications following delayed surgical removal.

To be directly comparable, the outcomes of the two strategies need to be summarised by a common method. This problem has been addressed in several decision analyses.[26,60–62] For example, 'days of standard discomfort' (DSD) was used as a single unit outcome measure to estimate extraction outcome in a decision analysis by Tulloch and Antczak-Bouckoms.[61] In another study, the outcome was measured by a utility value that "represents a condensation of the biological, physical, sociological, and psychological parameters that influence a person's sense of well-being".[26]

The major features and findings from the four identified decision analyses that compared different strategies for managing third molars are shown in appendix 4 (*Table 4*). A decision analysis by ECRI (an independent nonprofit health services research agency) has been included in *Table 4* but will not be discussed in detail here because it considered only economic consequences after different strategies.[39] The ECRI study concluded that there are no reliable predictors of pathological changes and disease and that although prophylactic removal of

third molars decreases the likelihood of future pathological changes and post-operative complications, it does not alleviate anterior dental arch crowding. Surgery may benefit only one in six patients, and the procedure may be associated with potential risks from post-operative complications, such as nerve damage.

Tulloch and Antczak-Bouckoms (1987)[61]

Three strategies of the management of lower third molars were evaluated by Tulloch and Antczak-Bouckoms:[61]

- removing all disease-free third molars before their complete root formation
- removing only those teeth that remain impacted
- removing only those impacted teeth that had associated pathology.

The probabilities of complications associated with removal (pain, swelling, bruising, and malaise) were subjectively estimated by nine surgeons. The DSD associated with various complications were estimated by 46 clinicians. The results suggest that "the strategy of removing only pathologically involved impacted third molars is generally the risk-minimising option".

This decision analysis considered the expected disability following surgical removal of third molars but did not consider disability associated with pathological changes of retained third molars. The findings of this study may be questionable because the estimated values of input parameters (utility and probabilities) were based on the subjective judgements of clinicians, or were based on poor quality literature. However, the authors used sensitivity analysis to test a wide range of assumptions and found that the model is sensitive to the severity of the outcome "when these values become rather extreme".

Tulloch and colleagues (1990)[62]

The decision analysis carried out by Tulloch and colleagues[62] was similar to the analysis by Tulloch and Antczak-Bouckoms[61] in terms of the structure and estimates of input parameters. However, it also included the costs of different strategies. Clinicians' reported fees and patient records were used to estimate the cost of the surgical procedure, and the cost (1985 US dollars) of treating any pathological changes associated with third molars or complications of surgery.

The results of this analysis suggested that the optimal strategy was to remove only impacted third molars with pathological changes. This strategy was associated with the lowest expected disability and also the lowest expected cost. Estimations of DSD were 2.27, 0.67, and 0.33 for all early removals, removal of impacted disease-free teeth, and removal of impacted teeth with disease, respectively. The central estimates of costs, presented as the cost per person if that strategy were universally adopted, were $247 for all early extractions, $66 for extractions of impacted teeth only, and $46 for extractions of impacted teeth with pathology. These findings maintained a similar pattern under best- and worst-case scenarios. Here the best-case scenario was "under the assumptions of least severe impactions, lowest chance of pathology, and lowest disability and cost associated with the outcome". The worst-case scenario was "the most severe impaction type, the greatest chance of pathology, and the highest estimates of disability and cost".

Brickley and colleagues (1995)[26]

In the analysis by Brickley and colleagues,[26] patient-derived utility values were used to measure patients' well-being following one of two strategies for the management of lower third molars: (1) removing all impacted third molars; (2) no intervention or conservative treatment. The estimated probabilities of outcomes were based on a literature review[15] and data from an audit, conducted by the authors, of 300 consecutive patients with third molar problems. The results showed that the maximum expected utility of non-extraction (76.96) was better than that for prophylactic third molar surgery (60.25). Results of a sensitivity analysis suggest that the outcome of non-extraction will be better than that of prophylactic third molar surgery unless the risk of disease with no extraction, relative to the risk shown by the clinical audit and literature review, is:

- 52% higher for pericoronitis
- 29% higher for resorption of an adjacent tooth
- 32% higher for loss of the adjacent tooth due to caries
- 43% higher for anterior incisor crowding
- 34% higher for cystic change.

Edwards and collegues (1999)[60]

The decision analysis by Edwards and colleagues[60] was similar to that by Brickley and colleagues,[26] using the same structure (decision tree) and a similar approach for estimating utility values and probabilities of outcomes. This decision analysis estimated and compared cost and cost-effectiveness of different strategies. In addition, the probabilities of various outcomes were estimated by an up-dated

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literature review (1966–98), and the values of utility were estimated by patients who attended the oral surgery clinic at the University of Wales Dental Hospital.

The average NHS cost was estimated as £170 for mandibular third molar retention, and £226 for surgical extraction, resulting in a marginal cost of –£56. The effectiveness of mandibular third molar management was rated as being greater for third molar retention (69.5) compared with surgical removal (63.3), giving a marginal effectiveness of 6.2. The incremental ratio of cost to effectiveness for retention compared with removal was therefore negative (–£56/6.2 = –£9.03 per extra unit of effectiveness). That is, mandibular third molar retention was less costly and more effective than prophylactic removal of disease-free third molars.

A sensitivity analysis indicated that this finding was sensitive to changes in the probability of pericoronitis, periodontal disease and caries. The most cost-effective strategy would alter from retention to removal if the probability of pericoronitis increased from 22% to 40%, the probability of periodontal disease increased from 5% to 17%, or the probability of unrestorable caries in the second molar increased from 10% to 22%.

Are the results of the decision analyses valid?

The validity of these decision analyses should be examined to decide whether their findings are believable. According to guidelines about using clinical decision analysis, the following questions need to be addressed:[95]

- were all important strategies and outcomes included?
- was an explicit and sensible process used to identify, select, and combine the evidence into probabilities?
- were the utilities obtained in an explicit and sensible way from credible sources?
- was the potential impact of any uncertainty in the evidence determined?

Were all important strategies and outcomes included?

The strategies compared in these decision analyses seem appropriate. Prophylactic removal of impacted third molars was compared with retention of disease-free third molars. In the analyses by Tulloch and colleagues[61,62] only complications following removal of third molars were considered. The outcomes of retention and removal of impacted third molars were included in the studies by Brickley and colleagues[26] and by Edwards and colleagues.[60] Decision analyses by Tulloch and colleagues[62] and by Edwards and colleagues[60] included the costs of different strategies.

Was an explicit and sensible process used to identify, select and combine the evidence into probabilities?

The probabilities of various outcomes were estimated by using subjective judgement of clinicians,[61] an audit of patients with third molar problems,[26] and literature reviews.[26,60–62] Although the process was explicitly described and seemingly sensible, details were often not available in the published decision analyses.

The risk of pathological changes associated with third molars may have been overestimated in the decision analyses when the proportions of patients with symptomatic impacted third molars were used to estimate the incidence of pathological changes among the total population with impacted third molars. On the other hand, probabilities of complications following third molar surgery were estimated by including patients undergoing prophylactic and non-prophylactic third molar surgery.

Were the utilities obtained in an explicit and sensible way from credible sources?

The methods used to obtain utility values were explicitly described in these decision analyses. The values of utilities were estimated by clinicians in one study by Tulloch and Antczak-Bouckoms,[61] and by patients in the decision analyses by Brickley and colleagues (1995).[26] The patient-derived utility used in the decision analyses by Brickley and colleagues[26] and Edwards and colleagues[60] seems more relevant and appropriate than the clinician-estimated utilities used in other studies.

Was the potential impact of any uncertainty in the evidence determined?

The potential impact of uncertainty in the evidence was tested by sensitivity analyses in all four decision analyses. According to the results of sensitivity analyses, findings were quite robust. The conclusions will alter only when the severity of the outcome or the probability of some disease changes considerably.

Time horizon

Perhaps the major weakness of these decision analyses is that they were not able to consider the impact of time span on the outcomes. The outcomes following surgical removal of third

molars occur early and are mainly short-term events (except permanent sensory nerve damage or other rare complications), whereas the outcomes associated with retention of disease-free third molars may occur in later life and can only be fully measured with a long-term follow-up. Patients' time preference and the impact of long-term outcomes may not have been fully incorporated into the decision analyses.

The cumulative probabilities of various pathological changes associated with impacted third molars may increase with a longer duration of follow-up, shifting the model more towards favouring extraction. On the other hand, the advantages of retention of disease-free third molars may be enhanced because of the effect of discounting the costs and/or disability which might be expected to occur at a more distant time, shifting the model more towards favouring retention.[62]

The usefulness of conventional decision analysis is limited when it is used to study clinical decisions that have long-term implications. When probability and utility variables change over time, Markov process analysis can be used but the modelling becomes much more complicated.[96] Markov modelling has been used, for example, to simulate the eruption of lower third molars.[97] A more complex Markov model may be helpful to explore long-term outcomes of prophylactic removal compared with retention of impacted third molars.

Summary of decision analyses

Although there were important differences in the structure and methods for estimating input values, the findings of the decision analyses (by two groups of researchers) consistently indicated that patients' well-being is maximised if surgical removal is confined to impacted third molars with pathological changes. Retention was the most cost-saving and cost-effective strategy compared with prophylactic removal of all impacted third molars.[60,62]

These decision analyses made it possible to compare different outcomes directly in the coherent models. The utility values and probabilities of various outcomes were explicitly presented. The uncertainty of input values was tested. Since there are no controlled studies comparing long-term outcomes of retention with outcomes of prophylactic removal of impacted third molars, the recommendations provided by the decision analyses may be relevant and important in relation to decision-making for the management of impacted third molars. Having said that, it should be stressed that these decision analyses were mainly based on research evidence from primary studies that had a poor quality of design.

Cost and cost-effectiveness analysis of prophylactic removal of third molars

According to data reported in *Extraction of wisdom teeth: submission of evidence to NICE* (by the Faculty of Dental Surgery of The Royal College of Surgeons of England), in 1995–96 the total number of third molar teeth removed was 121,577 (upper 42,578; lower 78,999), at a total cost of £11.8 million to the NHS General Dental Services (England & Wales).[98] Therefore, the average cost per third molar removed can be estimated as £97.06. According to the initial report of the UK National Third Molar project,[10] 43.9% of the third molars removed in 1995 were disease-free. Therefore it is possible to estimate that the total number of third molars removed prophylactically in 1995–96 was about 53,372 each year in the NHS General Dental Services (England & Wales) with a total cost of about £5.2 million. This estimated cost should be interpreted with caution. It is possible that the data reported are inaccurate, and details about cost are not available. In addition, the Faculty of Dental Surgery of the Royal College of Surgeons of England suggests that current rates of prophylactic removal are about 4%, much lower than the previous estimates. However, this needs to be confirmed.

The decision analysis by Edwards and colleagues estimated cost-effectiveness of removal and retention of disease-free third molars.[60] The cost to the NHS included consumables, staff costs, and overheads. The average cost (not discounted) of the prophylactic removal of an impacted mandibular third molar was about 33% higher than the cost of retention (£226 compared with £170).

The compensation awarded for permanent nerve damage after third molar surgery ranges from £5000 to £14,000 per case or higher.[99]

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Chapter 4

Discussion and conclusions

Quality of available evidence

The appropriateness of prophylactic removal of impacted third molars should be evaluated by comparing the outcomes of prophylactic removal with the outcomes of retention. One difficulty in the comparison of the two strategies lies in valuing and comparing the various outcomes. The outcomes of surgical removal of impacted third molars are assessed by the rate of various complications. On the other hand, the consequences of deliberate retention of impacted third molars without disease will include the incidence of different pathological changes and the rate of complications following delayed surgical removal. To be directly comparable, the outcomes of the two strategies need to be summarised by a common method, for example DSD or utilities.

RCTs

One RCT examined the effects of early extraction of third molars on late lower incisor crowding.[24] It concluded that the removal of third molars to reduce or prevent late incisor crowding cannot be justified. The preliminary results reported in an abstract describing another RCT, which aims to compare the effects and costs of prophylactic third molar removal with those of removal according to morbidity, suggested that watchful waiting may be a promising strategy but acknowledged that more data and longer follow-up of patients are needed to identify the most cost-effective strategy.[29] Additionally, a prospective multi-centre RCT has been commissioned in the USA, and results are awaited with interest. This RCT aims to compare removal with retention of third molars in terms of clinical, biological, and health-related quality of life outcomes. It is planned to compare these outcomes across patient groups stratified by age, gender, and race.[98]

Literature reviews

The general quality of the literature reviews identified is quite poor. Since authors did not explicitly describe review methods such as the search strategy and criteria for inclusion of individual studies, they might have selectively included those studies that supported their own opinion. The total number of references used in these literature reviews ranges from nine to 149. In our 1996 review of 12 literature reviews of impacted third molars we found that reviews with similar aims included different sets of studies as evidence from which to draw conclusions.[23] For example, 69 studies were quoted overall in nine general reviews to discuss the association between disease and third molars. None of these 69 references was used by more than five literature reviews. One study was quoted in five reviews, whereas 43 studies were included in only one review. This discrepancy in the use of relevant studies cannot be explained by the year of publication or by any other acceptable reason.

The identified literature reviews included primary studies with various designs such as retrospective or prospective observational studies and case reports. The relevance and quality of primary studies was inadequately assessed in the majority of cases. Sufficient details of the included primary studies were not presented and the interpretation of primary studies may not be valid. For example, some reviews used the proportion of patients undergoing third molar surgery to estimate the incidence of disease among populations. This approach may overestimate incidence considerably. In addition, when the incidence was reported, the duration of follow-up was sometimes unclear in the reviews. Since the quality of studies was not appropriately assessed, and sufficient details of studies were not presented, it is difficult to distinguish poor quality data from more reliable evidence provided in these reviews.

These literature reviews seldom quantitatively summarised the risk associated with removal or retention of impacted third molars. It is difficult to draw a balanced conclusion about the appropriateness of prophylactic third molar removal, partly because of the different outcomes of retention and removal that are used. Considering the complexity of the relevant issues and a lack of good objective evidence, it is perhaps unsurprising that the majority of reviews provide uncertain recommendations. However, it appears that literature reviews which conclude that prophylactic removal is inappropriate are of better methodological quality than many other reviews (appendix 3).

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Decision analyses

Several decision analyses made it possible to compare different outcomes directly in the coherent models. The utility values and probabilities of various outcomes were explicitly presented. The uncertainty of input values was tested. Since there are no controlled studies comparing long-term outcomes of retention and outcomes of prophylactic removal of impacted third molars, the recommendations provided by the decision analyses may be relevant to the decision-making process relating to the management of impacted third molars. However, it should be stressed that these decision analyses were mainly based on research evidence from primary studies that were of poor design quality.

Although there were important differences in the structure and methods for estimating input values, the findings of the decision analyses (by two groups of researchers) consistently indicated that patients' wellbeing is maximised if surgical removal is confined to those impacted third molars associated with pathological changes. Retention was the most cost-saving and cost-effective strategy compared with prophylactic removal of all impacted third molars.[60,62]

Conclusions

There is no reliable research evidence to support the prophylactic removal of disease-free impacted third molars. Available evidence suggests that retention may be more effective and cost-effective than prophylactic removal, at least in the short to medium term.

The results of two ongoing RCTs, one based in Denmark[29] and one in the USA, are awaited with interest.

Recommendations for research

1. Although data from observational studies may be useful, there is a need for well-designed RCTs to compare prophylactic removal with management by deliberate retention, using long-term follow-up.

2. There is also a need for decision analysis models that could be used to compare long term outcomes of prophylactic removal with retention of impacted third molars.

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The views expressed in this report are those of the authors, who are also responsible for any errors.

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Appendix 1

Search strategies

MEDLINE search strategy (1984–99)

1. molar third/ep,su,th,pc
2. molar third/
3. tooth impacted/
4. (third adj molar$).ti,ab,sh.
5. (wisdom adj (teeth or tooth)).ti,ab,sh.
6. (itm or itms).tw.
7. or/2-6
8. animal/
9. human/
10. 8 not (8 and 9)
11. 7 not 10

EMBASE search strategy (1984–99)

1. "molar-tooth"/epidemiology, prevention, surgery, therapy
2. "molar-tooth"/all subheadings
3. (third near1 molar*) in ti ab
4. (wisdom near1 (teeth or tooth)) in ti ab
5. (itm or itms) in ti ab
6. #1 or #2 or #3 or #4 or #5
7. nonhuman
8. explode "human"/all subheadings
9. #7 not (#7 and #8)
10. #6 not #9
11. #10 and (PY > "1983")

Science Citation Index (via BIDS) search strategy

Search: (wisdom teeth)@TKA,(wisdom tooth)@TKA,(third molar*)@TKA,(molar teeth)@TKA,(itm or itms)@TKA

CCTR search strategy

1. MOLAR-THIRD*:ME
2. (THIRD near MOLAR*)
3. (WISDOM near (TOOTH or TEETH))
4. ((#1 or #2) or #3)

DropBooks

Appendix 2

Summary of data extraction and quality assessment of RCTs

DropBooks

TABLE 1 *Data extraction of RCTs*

Reference, country, aim, design details	Participant selection criteria and baseline characteristics	Intervention details	Results	Withdrawals	Authors' conclusions and reviewers' comments
Harradine, *et al.*, 1998[24] UK *Research aim* To assess the effects of early extraction of third molars on late lower incisor crowding *Method of randomisation* Random number list *Sample size calculation* None reported *Outcome measurements* (1) Little's Irregularity Index (LII) (2) Intercanine width (ICW) (3) Arch length (AL) The above measurements were recorded at baseline and follow-up, and differences between the 2 time-points were calculated *Length of follow-up* Stated minimum was 5 years. Actual mean ± SD was 66 ± 12.6 months	*Inclusion criteria* (1) Patients who had previously undergone orthodontic treatment, but were no longer wearing any orthodontic appliances or retainers on entry to the study. Orthodontic treatment comprised active treatment in the upper arch only with either removable appliances or a single arch fixed appliance, with no treatment or premolar extractions only being carried out in the lower arch. (2) All patients had crowded third molars (i.e. third molars for which the long axis, and therefore presumed path of eruption, was through the adjacent second molar) *Exclusion criteria* Residual premolar extraction space *Baseline characteristics* Reported for overall sample, and not per study group Age of entry to the trial (mean ± SD): 14 years 10 months ± 16.2 months Gender: M, *n* = 74 (45%); F, *n* = 90 (55%)	*Group 1* Extraction of third molars (*n* = 44) *Group 2* Retention of third molars (*n* = 33) *Setting of treatment* Bristol Dental Hospital	*Statistical techniques* *t* tests, associated confidence intervals (CIs) *Mean ± SD change in LII* Group 1: 0.80 ± 1.23 mm Group 2: 1.10 ± 2.72 mm (*p* = 0.55) *Mean ± SD change in ICW* Group 1: –0.37 ± 0.73 mm Group 2: 0.38 ± 0.85 mm (*p* = 0.92) *Mean ± SD change in AL* Group 1: –1.1 ± 1.13 Group 2: –2.13 ± 0.97 (*p* = 0.001) A similar pattern of results was found when cases with residual space from premolar extraction on trial entry were excluded Data for the upper arch showed no statistically significant differences between the 2 groups for any measurement	Overall 77 patients (47%) completed the trial, of whom 45 (58%) were females Generalised linear modelling demonstrated no systematic differences between those patients who completed the study, and those who were lost to follow-up	*Authors' conclusions* The removal of third molars to reduce or prevent late incisor crowding cannot be justified *Reviewers' comments* Limitations of the study: overall, this is a well-conducted trial. Much of the analysis focuses on differences between completers and those who were lost to follow-up. More details about comparability of study arms at baseline would have been useful

AL = arch length, CI = confidence interval, LII = Little's Irregularity Index, ICW = intercanine width, SD = standard deviation

continued

TABLE 1 contd *Data extraction of RCTs*

Reference, country, aim, design details	Participant selection criteria and baseline characteristics	Intervention details	Results	Withdrawals	Authors' conclusions and reviewers' comments
Vondeling, *et al.*, 1999[29] Denmark *Research aim* To compare the effects and costs of prophylactic removal of third molars versus removal according to morbidity *Method of randomisation* Not stated; blocked and stratified allocation used *Sample size calculation* None reported *Outcome measurements* Clinical effectiveness and quality of life, using generic questionnaires Economic evaluation, applying a societal perspective *Length of follow-up* 6 years (Group 2)	*Inclusion criteria* Healthy participants aged 18–30 years, with at least one mandibular third molar *Exclusion criteria* None stated *Baseline characteristics* No information reported	*Group 1* Prophylactic removal of third molars *Group 2* Third molars removed according to morbidity Overall n = 200 at this stage (study ongoing) The anticipated group sizes for the completed study are: Group 1, n = 100 Group 2, n = 400	Prophylactic removal of third molars is associated with decreased functional health status for about a week, considerable healthcare costs, and production losses in the majority of patients. So far, very few patients in the watchful waiting group have developed an indication for removal	No information supplied	*Authors' conclusions* Watchful waiting may be a promising strategy. More data and longer follow-up of patients are needed to conclude which treatment strategy is the most cost-effective *Reviewers' comments* Limitations of the study: data are taken from abstract. These are preliminary results only, and the study is ongoing

DrodBooks

TABLE 2 *Methodological assessment of RCTs*

Reference, location	**Clear inclusion and exclusion criteria?**	**Overall sample size (number of arms)**	***A priori* sample size calculation?**	**Method of randomisation**	**Comparability of groups reported at baseline?**	**Blinded outcome assessment?**	**Appropriate methods used for statistical analysis?**	**Withdrawals**	**Intention to treat analysis?**
Harradine, *et al.*, 1998[24] UK	Yes	164 (2)	No	Random number lists	No	Yes	Yes	Reported, but not by group or no reason for withdrawal stated	No – but characteristics of non-responders were examined
Vondeling, *et al.*, 1999[29] Denmark	Yes (brief)	200 (2), but total sample not yet recruited	No	Not stated	No	Not stated	Descriptive summary	Not stated	Not stated

Appendix 3

Summary of data extraction and methodological assessment of literature reviews

DropBooks

TABLE 3 *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Anderson, 1998[30] USA	To review the factors relating to the removal of asymptomatic third molars in order to help dentists provide better patient treatment as opposed to 'overtreatment' Total references: 27	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The best overall strategy for the management of asymptomatic third molars is to remove those teeth that, clinically and radiographically, are either impacted or have minimal chance for eruption before the patient reaches the late 20s. For asymptomatic third molars that appear to have a chance for eruption or are erupted, and for asymptomatic impacted third molars in older patients, periodic examination of the patient is acceptable, so long as the patient has been informed of the relevant risks and benefits of observation	This is a narrative review in which subjective opinions are expressed that support the prophylactic removal of third molars. It is difficult to judge the comprehensiveness and reliability of the review as there are no details of a search strategy, selection criteria for primary studies, or quality assessment of the data
Bertrand, *et al.*, 1989[31] France	The review objective is not clearly stated, but appears to be to discuss various aspects of the management of wisdom teeth Total references: 108	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The incidence of pathology has been reduced during the last 20 years because of the tendency for orthodontists to systematically remove third molar germs. The importance of the correct diagnosis of morbidity associated with retention should be highlighted. Third molar surgery may be associated with various peri- and post-operative complications	This review is presented as a series of chapters covering various aspects of third molar management. The review methodology is poor, and the objectives and conclusions are unclear. Some references are given for the section describing retention-associated disease, and a single reference is provided for complications of surgery. It is unclear whether the references are evaluations of pathological changes/complication rates, or whether they are articles that merely describe the problems

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Bishara, 1999[32] USA	To review some of the pertinent studies related to the management of third molars in an orthodontic context Total references: 30	1. Fair 2. NA 3. NA 4. NA 5. Fair 6. Poor	/–	The influence of third molars on alignment of anterior dentition may be controversial, but there is no evidence to incriminate these teeth as being the major aetiological factor in the post-treatment changes in incisor alignment. The evidence suggests that the only relationship between these two phenomena is that they occur at approximately the same stage of development i.e. in adolescence and early childhood. However, this is not a cause and effect relationship	Most of the data appear to be from observational studies. With no information about the search strategy, selection criteria and study quality, findings should probably be interpreted with caution
Bonetti, et al., 1988[33] Italy	To review the indications for third molar extraction Total references: 24	1. Fair 2. NA 3. NA 4. NA 5. Fair 6. Fair	/–	Since there is no clear evidence relating to the importance of third molars in creating dental crowding, it is inappropriate to undertake prophylactic extraction	This review focuses on the problem of crowding. Retention-associated pathological changes and surgical complications are listed in tables. There are three references in the text which do not appear in the bibliography. No details are provided of study identification, selection or quality
Bramante, 1990[34] USA	To review the current thinking on retention and the influence of third molars on lower anterior crowding (in an orthodontic context) Total references: 64	1. Fair 2. NA 3. NA 4. NA 5. Poor/fair 6. Poor	/–	The mandibular third molar probably does exert an insignificant force on the dental arch during its eruption. However, the third molars do not significantly influence the crowding of the lower anteriors	A number of observational studies were reviewed with regard to the association between the presence of third molars and overcrowding. There is no description of a literature search or any mention of selection criteria or quality assessment of studies

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

Document Books

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Brokaw, 1991[35] USA	To review the considerations that a dentist should take into account when making recommendations concerning both erupted and unerupted third molars Total references: 9	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	Prevention of future problems or correcting of an existing pathologic condition will necessitate the removal of third molars in many patients presenting themselves in the dental office. The dentist should be aware of a number of considerations that are required to formulate a diagnosis and treatment plan concerning the removal of third molars	This is a very brief review of the morbidity associated with retention of third molars. The review methods are very poor. The text is frequently under-referenced, and even where references are cited, reliability of data is unknown
Cade, 1992[36] USA	To review paraesthesia of the inferior alveolar nerve as a result of the extraction of the mandibular third molars Total references: 17	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/	The best advice for prevention of inferior alveolar nerve injury (quoted from Merrill, 1979)‡: "there is probably no better way to avoid injury to the inferior alveolar nerve than by prophylactic removal of mandibular third molars before roots are completely formed. Injury to the nerves is unusual in patients under the age of 18"	This is a brief review of 3 retrospective studies or case reports, and some anatomy or physiology studies. The 'best advice' from the author quoted is not based on the evidence included in the review
Chikhani, *et al.*, 1994[37] France	The objectives are not explicitly stated by the authors, but appear to be to discuss lingual nerve injury during extraction of mandibular wisdom teeth Total references: 13	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The incidence of lingual nerve damage during extraction of mandibular third molars is less than inferior dental nerve damage, estimated at 1.3% versus 2–4% by most authors	This review focuses on various aspects relating to lingual nerve injury following third molar surgery. The section on incidence is very brief. Review methods are poor

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*

† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*

‡ Merrill RG. Prevention, treatment and prognosis for nerve injury related to the difficult impaction. *Dent Clin North Am* 1979;**23**:471–87

NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Daley, 1996[19] Canada	To review third molar prophylactic extraction with respect to the pathological changes associated with impacted third molars, and the assumption that younger patients have significantly less post-operative morbidity compared with older people. Total references: 145	1. Fair 2. NA 3. NA 4. NA 5. Poor/fair 6. Fair	/–	Data indicate that the risk of pathological changes associated with impacted third molars or their follicles is low in middle-age[d] and older people, who exhibit a slightly higher risk of increased surgical morbidity than younger individuals. Based on available data, routine prophylactic third molar extraction is unjustifiable	The coverage of literature is more comprehensive than in many other reviews. Lists of references are presented in tables according to different pathological and post-operative outcomes. However, there is a lack of information about review methods. There is an analysis of the rates of surgical complications in older and younger populations
Dénes, *et al*., 1993[38] Hungary	Not clear, but appears to be to discuss the problems associated with impacted third molars Total references: 9	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/	Prophylactic removal of third molars is recommended because it reduces the anticipated problems and is advantageous for orthodontic treatment	The main focus of the review is crowding associated with third molar retention. The review methodology is poor, with very few details provided for primary studies

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

Prop Books

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
ECRI, 1993[39] USA	To review factors concerning the removal of mandibular third molars Total references: 21 (chapter 4)	1. Poor 2. NA 3. NA 4. Poor 5. Poor/fair 6. Fair	+/–	There are no reliable predictors of pathology. No controlled longitudinal studies have examined the effectiveness of prophylactic wisdom teeth removal. In the absence of such studies, it seems that prophylactic removal decreases the likelihood of future pathology and post-operative complications, but does not alleviate anterior dental arch crowding. However, surgery may benefit only one in six patients. Furthermore, performing prophylactic surgery on all patients subjects them to potential risks from post-operative complications such as nerve damage	This is a relatively comprehensive literature review. The analysis includes disease associated with retention of third molars, post-operative complications, rates of these by age of patients, cost-effectiveness, and a decision tree constructed from assumptions derived from the literature. It is difficult to assess the methodological quality of the review because of the lack of information about methods and sources used
Flick, 1999[40] USA	To summarise the current research available concerning the removal of impacted third molars, and provide a background from which practitioners, public health policy advocates, and third-party payers can more objectively assess the issues of appropriateness of care and overutilisation of third molar surgery Total references: 29	1. Fair 2. NA 3. NA 4. Poor 5. Poor 6. Poor	+/–	There is a need for large population-based studies to provide practitioners with data to help them decide when third molar surgery is appropriate. There is little agreement on how many third molars are being removed for so-called prophylactic reasons. The available non-intervention studies are few and have significant flaws. The studies that argue against prophylactic removal are largely based on statistical models. The application of these models as a basis for clinical decision making is questionable. The effects of provider supply and reimbursement must be considered as an integral part of the controversy	Initially this review seems quite promising, but does not in fact include a very comprehensive coverage of the literature. There are sections on retention-associated morbidity, outcomes of surgery, and cost-effectiveness. For the first two, the data provided are very general. For cost-effectiveness, data are discussed within a North American context. The very general nature of the narrative, together with a lack of information about the review methods, means that results should be interpreted with caution

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Forssell & Miettinen, 1988[41] Finland	To examine indications and contraindications for the removal of mandibular third molars. To examine the effects of treatment in different age groups Total references: 23	1. Fair 2. NA 3. NA 4. NA 5. Fair 6. Poor	/–	Wisdom teeth extraction in younger people involves fewer and less severe complications. However, removal should not be considered as routine	This review focuses mainly on the pathological changes and symptoms associated with third molar retention, although there are a small number of references relating to surgical complications. References are cited in the text but a bibliography is not provided; it is stated that this is available elsewhere via the journal. Although reasonable study details are given (e.g. sample sizes), the review methodology is generally poor
Garattini, *et al.*, 1990[42] Italy	To review the literature on the role of the mandibular third molar on crowding; to review the role of germectomy as a treatment Total references: 48	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Fair	/–	Mandibular third molars are only one of several factors which may contribute to malocclusion. Germectomy should be performed in selected patients only, after a comprehensive diagnostic evaluation on an individual basis	The main focus of this review is the problem of crowding associated with retention of third molars. Since no details are provided of identification, selection, or appraisal of primary studies, findings should be treated with caution
Goia, *et al.*, 1990[43] Italy	To review the indications for extraction of impacted third molars Total references: 20	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Fair	/–	Third molar extraction should be performed only in cases of severe crowding. In cases of slight crowding, third molars should be retained as they have a positive role	This review focuses on the problem of crowding. Some useful details of primary studies are provided, relating to numbers of patients and length of follow-up. However, since no information is given for sources of studies, nor of their selection or methodological quality, the review's findings should be interpreted with caution

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

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TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Jacquiéry, *et al.*, 1994[44] Switzerland	To present the indications and contraindications of third molar surgery Total references: 28	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/	The decision to extract a mandibular wisdom tooth is obvious in the case of pathology or recurrent pericoronitis, but the need for prophylactic extraction of asymptomatic wisdom teeth is less so. Generally, it is reasonable to encourage prophylactic extraction in young patients in cases where normal eruption is unlikely to take place. The number of post-operative complications in young people is relatively low. In the case of temporary contraindications (apart from pericoronitis), referral of the patient to specialist services is recommended since peri- and post-operative complications can be managed more easily	This paper focuses on the indications and contraindications for third molar surgery. The review methodology is poor, with no information on study identification, selection, or validity. Also, few details of the primary studies are given. Therefore the evidence presented should be interpreted with caution
Kugelberg, 1992[45] Sweden	To address the advances in the diagnosis and treatment of impacted third molars with special emphasis on periodontal health in the second molar area adjacent to the extraction site Total references: 29	1. Fair 2. NA 3. NA 4. NA 5. Poor/fair 6. Poor	+/–	[Predictors for risk of periodontal defect were reported.] Detecting the predictors in time is crucial for prevention of periodontal defects. If these factors are neglected during adolescence, they may predispose the individual to advanced marginal periodontal breakdown later in life in the second molar area adjacent to the extraction site. For patients over 30 years of age, it is better to avoid surgery until symptoms appear	This review presents an index for predicting risk for periodontal defects after surgery, based mainly on the reviewer's own studies. There is little information about review methods, and therefore findings are difficult to interpret with any degree of confidence

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Lechien, 1995[46] Belgium	To review pathology associated with retention of impacted teeth; to review possible complications of extraction and other treatment strategies Total references: 16	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/	Since the incidence of retention-associated pathology and surgical complications increase[s] with age, surgical management of impacted third molars which are not in a favourable position or when posterior eruption space is inadequate, is recommended. Impacted teeth which are partially or completely covered by soft tissue should also be removed if they cannot adopt a good position in the dental arch	Although this review discusses all types of impacted teeth, most of the references relate to management of third molars. Statements made in the text are not always supported by references. The review methodology is poor
Mercier & Precious, 1992[15] Canada	To review the scientific literature on the third molars as it pertains to both risks and benefits of intervention and non-intervention of impacted third molars Total references: 149	1. Fair 2. NA 3. NA 4. NA/poor 5. Poor 6. Fair	+/–	Absolute indications and contraindications for the removal of asymptomatic third molars cannot be established because no long-term studies exist which validate the benefit to the patient either of early removal or of deliberate retention of these teeth. It appears that the best general approach for the surgeon is to remove, on the basis of clinical judgement, some teeth before the age of 14, and others before the age of 22, when chances of eruption are minimal. The best strategy after this age is periodic examination of patients who have been fully informed about relevant risks and benefits. Ultimately, the surgeon must weigh the facts and put the interests of the patient above all else	The review appears to include a good coverage of the literature, but there are no details of review methods. Rates of morbidity and post-operative complications are presented for most of the individual studies, but there is no reported assessment of the validity of the primary material. Risks and benefits of different strategies are subjectively rated and presented

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

Reprint Books

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Mommaerts, *et al.*, 1991[47] Belgium	To discuss lingual nerve injury during extraction of mandibular wisdom teeth. Total references: 66	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The incidence of temporary dysfunction of the lingual nerve ranges from 0.1% to 6.6% across studies. The incidence range for permanent dysfunction is 0% to 0.1%	Although the details on incidence are useful, there is no consideration of the appropriateness of routine third molar extraction in light of these data. The review methods are poor, with few details of the selection and characteristics of primary studies
Peterson, 1992[48] USA	To review and discuss indications and contraindications for removing impacted teeth Total references: 22	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	While not every impacted tooth causes a significant problem, each has that potential. If the impacted third molar is partially impacted and partially exposed, it should be removed as soon as possible. The completely impacted, asymptomatic third molars in a patient older than 35 can be left intact unless a pathological condition develops	This is a very brief literature review that concentrates on issues concerning periodontal healing, but does include some other information. There is no information on the review methods, so the reliability of the information presented is difficult to assess
Robinson, 1994[50] UK	To discuss the indications for and risks of wisdom tooth removal, and suggest guidelines for dealing with the dilemma Total references: 9	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	Teeth that are symptomless and likely to remain so are normally best left in place. Thoughtless neglect of the apparently harmless impacted third molar may lead to unacceptable morbidity; on the other hand, cavalier extraction of any or all third molars is the fuel of litigation	This is a brief literature review, covering prevalence of third molar impaction, indications for removal or retention, and risks of surgery. There is no information about the review methods, so the information reported is difficult to assess in terms of reliability
Robinson & Vasir, 1993[49] UK	To discuss the impact of mandibular third molars on incisor crowding Total references: 17	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Fair	/–	Methods of predicting third molar behaviour are unreliable. The mandibular third molar has a weak association with late crowding of lower incisors. Ideally, RCTs with large samples, matched in respect of specific variables, will provide clearer answers	This review concentrates specifically on the aspect of crowding and third molars. There is no information about review methods. The authors point out that all the studies reviewed are of retrospective design, or have other weaknesses

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Sands, *et al.*, 1993[51,52] Canada	To review the literature on the major controversies and discuss some of the misconceptions associated with third molar surgery Total references: 72	1. Poor 2. NA 3. NA 4. NA/poor 5. Poor/fair 6. Fair	/–	There is a tendency to exaggerate the incidence of significant pathology associated with impacted third molars. The suggestion that all wisdom teeth should be removed cannot be supported	This review covers both retention-related morbidity and post-operative complications. There is no information about the review methods, so it is difficult to assess the reliability of the data
Southard, 1992[53] USA	To review recent evidence on third molar and incisor crowding and the appropriateness of removal Total references: 21	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	/–	Removing impacted third molars for the exclusive purpose of relieving interdental force and thereby preventing incisor crowding is unwarranted	This review concentrates on the impact of unerupted third molars on incisor crowding. Because there are no details of review methods, the information presented may be of limited reliability
Stephens, *et al.*, 1989[13] Canada	To critically evaluate the scientific literature used as the basis for the rationale of prophylactic removal of unerupted or impacted third molars Total references: 65	1. Fair 2. NA 3. NA 4. Poor/fair 5. Poor/fair 6. Fair	/–	Prophylactic removal of asymptomatic or non-pathologically involved impacted teeth is a questionable practice. Extraction should be limited to those teeth with defined pathologic indications such as infection, cysts, tumours, resorption and unrestorable caries	Details of review methods were not presented, so the reliability of the review cannot be assessed. There is more detail on the primary studies, compared with many other reviews

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

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TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Tate, 1994[54] USA	To review the aetiology and potential pathology of impacted teeth, and discuss indications and contraindications for extraction Total references: 27	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/	The overwhelming body of evidence shows that patients who wait until symptoms develop before having impacted teeth removed suffer undue discomfort, prolonged recovery and increased expense, as well as damage to the bony support of adjacent teeth. Thus, in the absence of active symptoms, the indications for removal of impacted teeth fall clearly in the realm of preventive dentistry	There is no information on review methods, and so it is not possible to assess the evidence presented Several studies about pathological changes associated with retained third molars were reviewed but only one about complications after third molar surgery. It is possible that available evidence has been selected to support the author's beliefs and practice
Tealdi & Domini, 1986[55] Italy	To review published studies on the indications for extracting impacted third molars Total references: 15	1. Fair 2. NA 3. NA 4. NA 5. Poor 6. Fair	+/–	The contraindications to extracting impacted mandibular third molars are: absence of molars or pre-molars, intention to extract first or second permanent molar, and extraction of first or second molar due to caries/periodontitis. There is a lack of consensus relating to the indications for removal of impacted third molars, apart from cases of third molar caries, or when cysts/tumours are present	This review focuses on the problems of third molar retention. The objectives are clear, and some useful details of the primary studies are given. However, there are no details of how studies were identified or selected. There is a reference in the text that is not included in the bibliography
Torres, 1997[56] France	To determine why, when, and which teeth should be removed or retained Total references: 33	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Fair	/–	In clinical practice, it is likely that a very large proportion of wisdom teeth are extracted without indication. Such interventions, without clinical motive, can lead to minor health problems, as well as considerable costs relating to absence from work, convalescence, and medico-legal outcomes for practitioners	This review attempts to discuss the risks and benefits associated with retention and removal of wisdom teeth. The review methodology is generally poor. Several references are cited for different aspects of retention-associated pathology and surgical complications

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

continued

TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Toth, 1993[4] UK	To evaluate the appropriateness of prophylactic extraction of impacted third molars Total references: 74	1. Fair 2. Fair 3. Poor 4. Poor/fair 5. Fair 6. Fair	/–	Prophylactic surgery is not an appropriate management strategy for asymptomatic impacted third molars. Current evidence does not permit a conclusion on the appropriateness of prophylactic surgery when impacted third molars have been associated with one or more episode of pathology	This review is better than many others in that it mentions a search strategy, gives useful details about some of the primary studies, and highlights some of the problems within the primary studies. Further details about the review methods (i.e. how studies were selected) would have been useful. The complications after third molar surgery were not reviewed
van der Linden, *et al.*, 1993[57] South Africa	To review/discuss the appropriateness of removal of third molars Total references: 37	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The arguments both for and against the prophylactic removal of impacted third molars are all valid. Each case should be assessed on its merits. The decision whether or not to remove the third molars should take the overall benefit to the patient's oral status and general health into account	This review was mainly about the indications or contraindications for third molar surgery. There is no information about review methods, so it is difficult to interpret the evidence presented
Vasir & Robinson, 1991[22] UK	To review literature on whether mandibular third molars affect incisor crowding Total references: 59	1. Poor 2. NA 3. NA 4. Poor/fair 5. Poor/fair 6. Fair	/–	The mandibular third molar has a weak association with late crowding of lower incisors	Some details are given in the text relating to primary studies. However, further information about primary material and review methods would be required to make definitive conclusions from this evidence

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

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TABLE 3 contd *Data extraction and methodological assessment of literature reviews*

Reference, country	Objectives	Review methods*	Review's conclusions†		Assessors' commentary
Waite & Reynolds, 1998[58] USA	To discuss factors related to impacted teeth and help the orthodontist understand the general management of impacted third molars Total references: 28	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	The benefit of prophylactic removal of third molars is the possible prevention of potential disease at a time when the surgical risk is minimal. Ultimately, the decision to remove impacted third molars is based on a variety of factors judged to be important by the patient and the dentist. Further research is needed before categorical decisions can be established for the management of impacted third molars	There is no information on review methods, so it is not possible to assess reliability of data. This review concentrates more on pathology rather than complications of surgery
Weisenfeld & Kondis, 1991[59] USA	To review the literature on prophylactic removal of impacted third molars Total references: 9	1. Poor 2. NA 3. NA 4. NA 5. Poor 6. Poor	+/–	It is clear from numerous publications that a diagnosis of third molars as pathological simply because they are present is not appropriate. The clinical decision about whether they should be extracted should be made on an individual basis after proper consideration of tooth development, position, size, patient age, and growth potential	This review is extremely brief. It is difficult to infer much from this paper, due to its brevity, and lack of detail about methods

* *Review methods: 1. Does the review answer a well-defined question? 2. Was a substantial effort to search for all the relevant literature made? 3. Are the inclusion/exclusion criteria reported and appropriate? 4. Is the validity of included studies adequately assessed? 5. Is sufficient detail of the individual studies presented? 6. Have the primary studies been summarised appropriately?*
† *Review's conclusion about appropriateness of prophylactic removal of impacted third molars: +/– = uncertain; +/ = supporting prophylactic removal; /– = against prophylactic removal*
NA = not reported

Appendix 4

Data extraction summary for decision analysis studies

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TABLE 4 *Data extraction summary for decision analysis studies*

Reference, country	Strategies compared	Outcome and utility estimating	Probability estimating	Cost estimating	Main findings	Sensitivity analysis
Tulloch & Antczak-Bouckoms, 1987[61] USA	1. Removing all 3Ms 2. Removing only impacted 3Ms 3. Removing impacted 3Ms with disease	Complications associated with removal of 3Ms. DSD is defined in terms of the disability normally associated with an uncomplicated surgical extraction of a 3M – namely, pain, swelling, bruising and malaise. 46 clinicians (oral surgeons, orthodontists or general dentists) were asked to rate the value of DSD according to their belief about the morbidity or disability associated with each complication	Probability of each complication was subjectively estimated by a group of experts using a Delphi technique The proportion of 3Ms with various degrees of impaction and the probability of disease associated with retained 3Ms were derived from the published literature	–	Under a wide range of assumptions about the likelihood of different impaction types, chance of disease, probability of extraction complications, and disability associated with each complication, the strategy of extracting only disease-associated impacted mandibular 3Ms is generally the risk-minimising option	For each input parameter, 3 estimates were used: low, central, and high value. The results using these 3 values were consistent. The finding was sensitive to the severity of the outcome, although only when these values become rather extreme
Tulloch, *et al.*, 1990[62] USA	1. Removing all 3Ms 2. Removing only impacted 3Ms 3. Removing impacted 3Ms with disease	Costs and complications associated with removal of 3Ms DSD is defined and estimated as in Tulloch & Antczak-Bouckoms (1987)[61]	Probability of complications, 3Ms with various degrees of impaction, and disease associated with retained 3Ms were estimated as in Tulloch & Antczak-Bouckoms (1987)[61]	The costs of the surgical procedure and of treating any disease or complications of surgery were estimated on the basis of clinicians' reported fee and a review of patient records	Removing only those 3Ms that remain impacted and become associated with disease is always associated with less expected cost and disability than prophylactic removal of asymptomatic wisdom teeth	The optimal strategy (retention of 3Ms) remained the same under both the 'best-case' scenario and the 'worst-case' scenario

3M(s) = third molar(s)

continued

TABLE 4 contd *Data extraction summary for decision analysis studies*

Reference, country	Strategies compared	Outcome and utility estimating	Probability estimating	Cost estimating	Main findings	Sensitivity analysis
ECRI, 1993[39*] USA	1. Prophylactic surgery 2. No prophylactic surgery	Economic consequences	Probabilities of complications following 3M surgery were based on data from the literature	Costs were taken from the high end of fees reported in 1990 in the published literature	It is cost-effective to deny prophylactic surgery if less than 30% of the non-prophylactically treated patients require surgery after 20 years	Different percentages of patients undergoing prophylactic surgery and/or different percentages of patients requiring surgery were used in the model
Brickley, *et al.*, 1995[26] UK	1. Removing all impacted 3Ms 2. Conservative treatment	Outcomes following surgical removal of lower 3Ms, or following non-intervention Utilities of the outcomes were measured using a VAS, rated by 104 individuals, age- and sex-matched to a cohort of patients who had undergone lower 3M surgery. Zero indicates 'things could not be worse' and 100 indicates 'I would not be bothered at all'	The probability of each outcome was estimated using a literature review (a computerised search and a review by Mercier & Precious, 1992[15]), and data from an audit of 300 consecutive patients with 3M problems	–	The maximum expected utility of prophylactic 3M surgery (60.25) was lower than that for non-intervention (76.96)	The finding was sensitive to changes in the probabilities of occurrence of recurrent pericoronitis (threshold, 0.52), resorption of an adjacent tooth (threshold, 0.29), loss of an adjacent tooth (threshold, 0.32), and cystic change (threshold, 0.34)

[*] *Not discussed in detail in the text because it considers only the economic consequences of different strategies*
3M(s) = third molar(s); VAS = visual analogue scale

continued

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TABLE 4 contd *Data extraction summary for decision analysis studies*

Reference, country	Strategies compared	Outcome and utility estimating	Probability estimating	Cost estimating	Main findings	Sensitivity analysis
Edwards, *et al.*, 1999[60] UK	1. Surgical removal of asymptomatic disease-free 3Ms 2. Retention of asymptomatic disease-free 3Ms	Cost and health outcomes following 3M removal and outcomes of retention Utilities were measured by using a VAS. 100 patients were asked to rate the effect of each outcome on their own life. Zero indicates 'things could not be worse' and 100 indicates 'I would not be bothered at all'	Probabilities were estimated based on a comprehensive literature review: from a computerised MEDLINE search and manual search of the medical literature (1966–98). The probability of each outcome was the mean incidence reported from all of the relevant literature	Cost was measured in terms of direct economic cost in an NHS hospital and incorporated consumables, staff costs, overheads and equivalent annual costs	Mandibular 3M retention was less costly (£170), more effective (69.5 effectiveness units on a 100-point scale) and more cost-effective (£2.43 per unit of effectiveness) than removal (cost, £226; effectiveness units, 63.3; cost-effectiveness, £3.57). The incremental ratio of cost to effectiveness for retention vs. removal was –£56/6.2 = –£9.03 per extra unit of effectiveness	The finding was sensitive to changes in the probability of pericoronitis, periodontal disease and caries. The most cost-effective strategy would alter from retention to removal if: the probability of pericoronitis increases from 22% to 40%; the probability of periodontal disease increases from 5% to 17%; or the probability of unrestorable caries in the second molar increases from 10% to 22%

3M(s) = third molar(s); VAS = visual analogue scale

Appendix 5

Studies excluded from the review

TABLE 5 *Studies excluded from the review*

Reference, country	Title	Reasons for exclusion
Alling & Catone, 1993[66] USA	Management of impacted teeth	Does not specifically focus on third molars; description of problems of impaction; no outcomes reported
Anker, 1996[67] Australia	What is the future of third molar removal? A critical review of the need for the removal of third molars	No references cited, therefore not a review of the literature
Bakos & Pyle, 1991[69] USA	Odontogenic keratocyst involving impacted mandibular third molars	Few data reported in terms of the effects of third molar surgery
Benauwt, *et al,* 1989[68] France	Wisdom teeth. Arguments on the discussion question	Discussion notes from seminar/workshop. No references (apart from three irrelevant ones, cited in the paper, but not as bibliography)
Camplin, 1987[70] Croatia	What to do with impacted teeth?	Although the paper focuses on retention-associated problems, there are no details on the incidence of such problems. References are shown in the text but there is no listed bibliography
Commissionat & Roisin-Chausson, 1995[71] France	Inferior alveolar nerve injury during extraction of wisdom teeth	Description of radiographic and surgical techniques relating to inferior alveolar nerve damage; aslo covers characteristics of different lesions, and treatment. There is only one reference relating to incidence of nerve damage (4 references overall)
Cooper-Newland, 1996[72] USA	Management of impacted third molar teeth	General topic overview; no outcomes discussed
Di Gianfilippo, *et al.,* 1990[73] Italy	Removal of impacted teeth: indications and contraindications	Although a small bibliography is included at the end of the paper, no references are shown within the text
Garattini, *et al.,* 1988[74] Italy	Germectomy of lower third molars: indications and contraindications	Discussion of diagnostic techniques relating to, and optimal age for, germectomy
Garattini, *et al.,* 1988[75] Italy	Germectomy of lower third molars: surgical technique and selection criteria	Description of surgical techniques
Kalamchi & Hensher, 1987[76] UK	The management of impacted mandibular third molars 2. Treatment	Mainly about surgical technique; very few references cited

continued

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TABLE 5 contd *Studies excluded from the review*

Reference, country	Title	Reasons for exclusion
Klein & Lorber, 1995[77] Germany	Historical development of surgical wisdom tooth extraction	Historical review of surgical technique
Ko, *et al.,* 1999[78] Canada	Bilateral dentigerous cysts – report of an unusual case and review of the literature	The main purpose is to present the single case report; the literature review is very brief
Koerner, 1994[79] USA	The removal of impacted third molars	Description of different surgical techniques
Kokich & Matthews, 1993[80] USA	Surgical and orthodontic management of impacted teeth	Not specifically relating to third molars; description of surgical and orthodontic techniques
Leonard, 1992[81] USA	Removing third molars: a review for the general practitioner	General topic overview with few data on surgical outcomes from the literature
Lytle, 1995[82] USA	Etiology and indication for the management of impacted teeth	Does not specifically relate to third molars; few outcome data reported from the literature
MacGregor, 1990[83] UK	Reduction in morbidity in the surgery of the third molar removal	Does not discuss appropriateness of removal of third molars; proposes techniques and agents to reduce morbidity related to surgery
Pajarola, *et al.,* 1994[84] Switzerland	Surgical extraction of mandibular wisdom teeth	The main focus of the review is the comparison between two different surgical techniques for extraction; there are very few references relating to surgery related complications
Richardson, 1989[85] Northern Ireland	The role of the third molar in the cause of late lower arch crowding: a review	The main focus is a single small primary study; review of other studies is very brief
Sentilhes, 1988[86] France	Indications for wisdom teeth removal	No references
Seward, *et al.,* 1984[87] UK	Unerupted and impacted teeth	Does not specifically relate to third molars; not a review of the literature
Stamatis & Orton, 1994[88] Australia	The molar extraction debate	The focus of the article is extraction of second molars
Stavisky, 1989[89] USA	Clinical justification for the prophylactic removal of impacted third molars	No references cited, therefore not a review of the literature
Taft & Prigoff, 1987[90] USA	To extract or not to extract third molars	Discussion of how to predict impaction
Turcotte, *et al.,* 1987[91] Canada	The impacted third molar: extract or save?	Although a bibliography is shown (18 references), no references are cited in the text

continued

TABLE 5 contd *Studies excluded from the review*

Reference, country	Title	Reasons for exclusion
Turcotte, *et al.*, 1997[92] Germany	Alveolitis – current opinion	Focuses on methods of treating alveolitis rather than discussing appropriateness of routine extraction of third molars
Windecker & Kendzia, 1986[93] Germany	Third molar extraction from the prosthetic point of view	Primary study, not a literature review
Yamada, *et al.*, 1985[94] Japan	To what extent can we keep our own teeth? Indications for extraction	Does not focus on third molars. This paper is intended as a guide for dentists relating to preservation of all teeth

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We look forward to hearing from you.

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